N°Affaire	Phase	Mission	Indice	Auteur	Validé
22245	Stage 2	EC	2	DP	AV

Retrofit at 26A Ferncroft Avenue, London NW3 7PH
Option 1

Embodied carbon calculation

Stage 2

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SOMMAIRE

1 - CONTEXT

The project analysed in this study is the retrofit of a single household house in London. The retrofit aims to reach an EnerPHit Standard: insulation and energy efficiency are the main means of action to reduce the energy consumption under 120 kWh/m².year.
Reduction of energy consumption will lower the overall greenhouse gases emissions of the building. However, the use of materials for the retrofit may have a negative environmental impact. Therefore, the aims of this study are:
- evaluate the carbon emissions of the retrofit materials
- compare the environmental gains of energy savings to emissions due to material use.

2 - HYPOTHESIS

2.1 - Scope of the study

Every new material used in the retrofit and accounted in the cost plan is taken into account in the carbon calculation. This includes technical equipment for heating and domestic hot water production and distribution, as well as ventilation systems.

The following are not taken into account:
- Repairs, demolitions and disposal of existing materials
- Non fixed furniture (wardrobes, cupboards, mirrors)
- Smaller items (steel bearing plates, lighting installations, fire alarms and smoke detectors)
- Items with no carbon information available (showers, vacuum insulation panels).

The items are associated with emissions of greenhouse gases in kgCO2equivalent. The quantitative values of the emissions are given by Environmental Product Declarations (EPD) and are estimated for a building lifespan of 60 years. These emissions can be negative for bio sourced materials which absorb more CO2 in their production phase than emitted in the end-of-life phase.

2.2 - Quantities

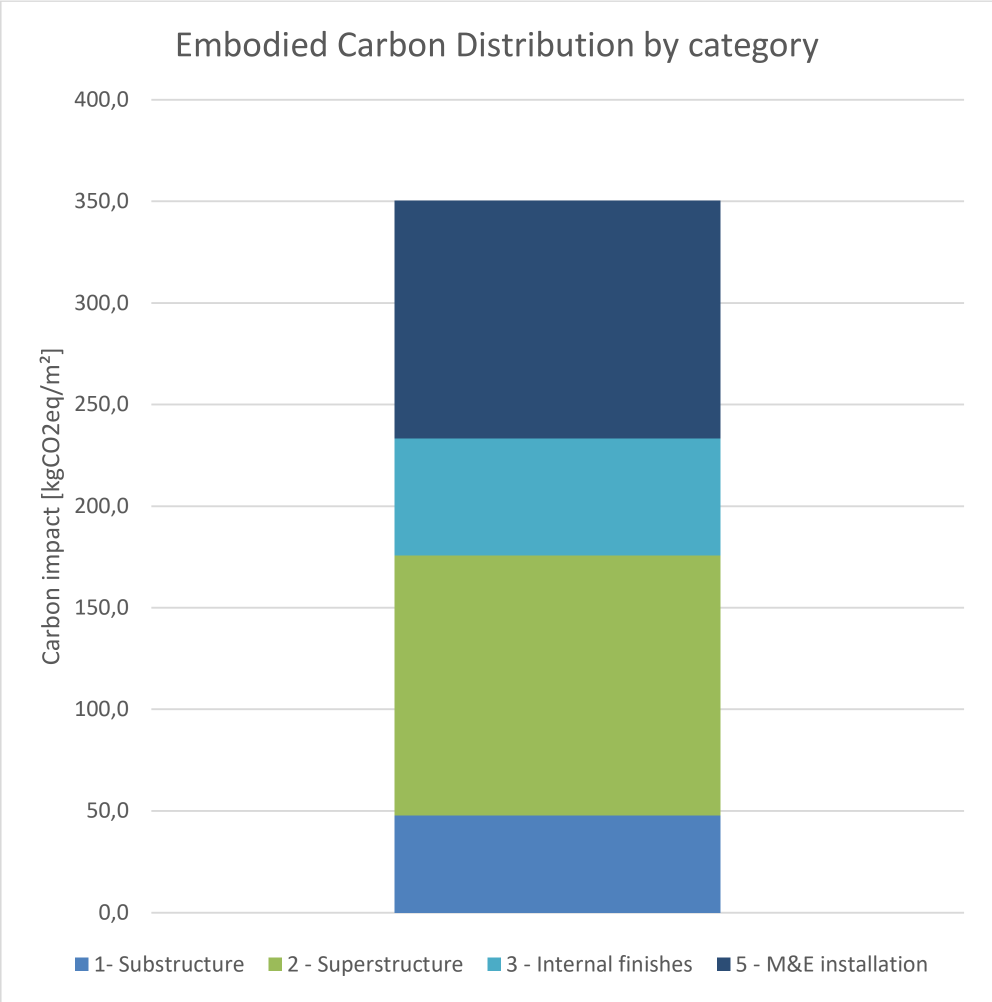
The quantities entered in the software are mainly provided by the cost estimation and completed with data from PHPP study when necessary. The length of ventilation and heating ducts have not been measured at this stage of the project, so typical ratios for dwelling buildings are used in the calculations
When needed, a unit conversion has been made to match the EPD unit. For example, one wash basin is regarded as 10 kg of ceramics.

2.3 - Production site

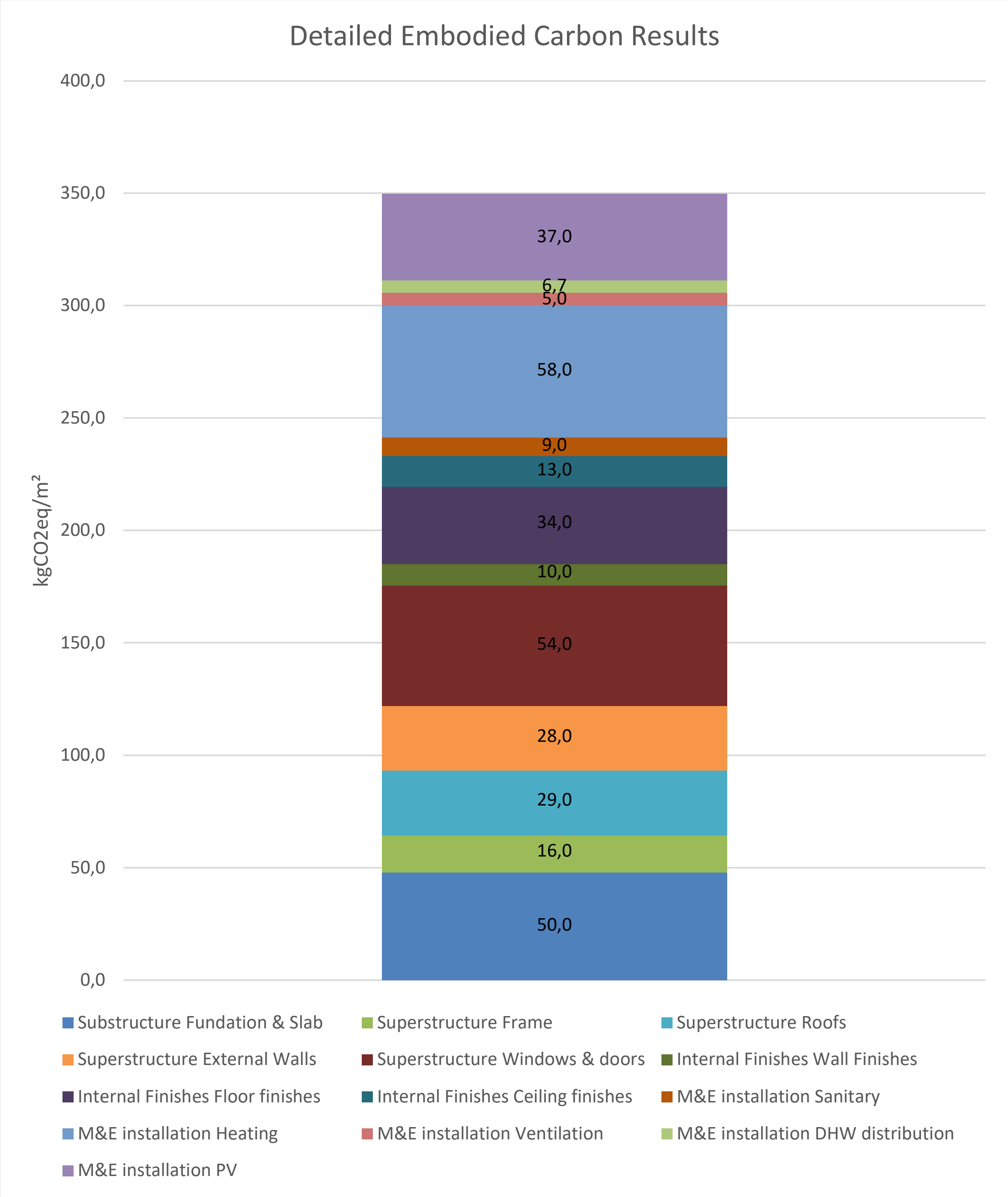
There are 4 production origins available in the calculation software: locally, nationally, Europe and World.
For the locally produced items, the distance from production site to project site is estimated at 50 km.
Most of the items are considered produced in England, i.e. in the “national” category of the software. The distance from production site to local provider is estimated at 300 km.
Windows, doors and wood fiber insulation are estimated from Central Europe i.e. in the “Europe” category. The distance calculated for these products is around 1500 km.
The chosen PV panels are mostly made in Mexico, they are put in the “world” category. The distance calculated for these products is 10 000 km.

Main results are detailed below.

A first analysis of the carbon impact of the entire building reveals superstructure (with mostly brick walls and steel, but also triple gazing windows, and doors) and equipment (heat pump and HRV) have the biggest impact. Important note: internal insulation is accounted in the “internal finishes” category.



A finer analysis confirms the major impact of the substructure (14% of the total carbon emissions). Triple gazing windows also account for a large part of the emissions (more than 16%).



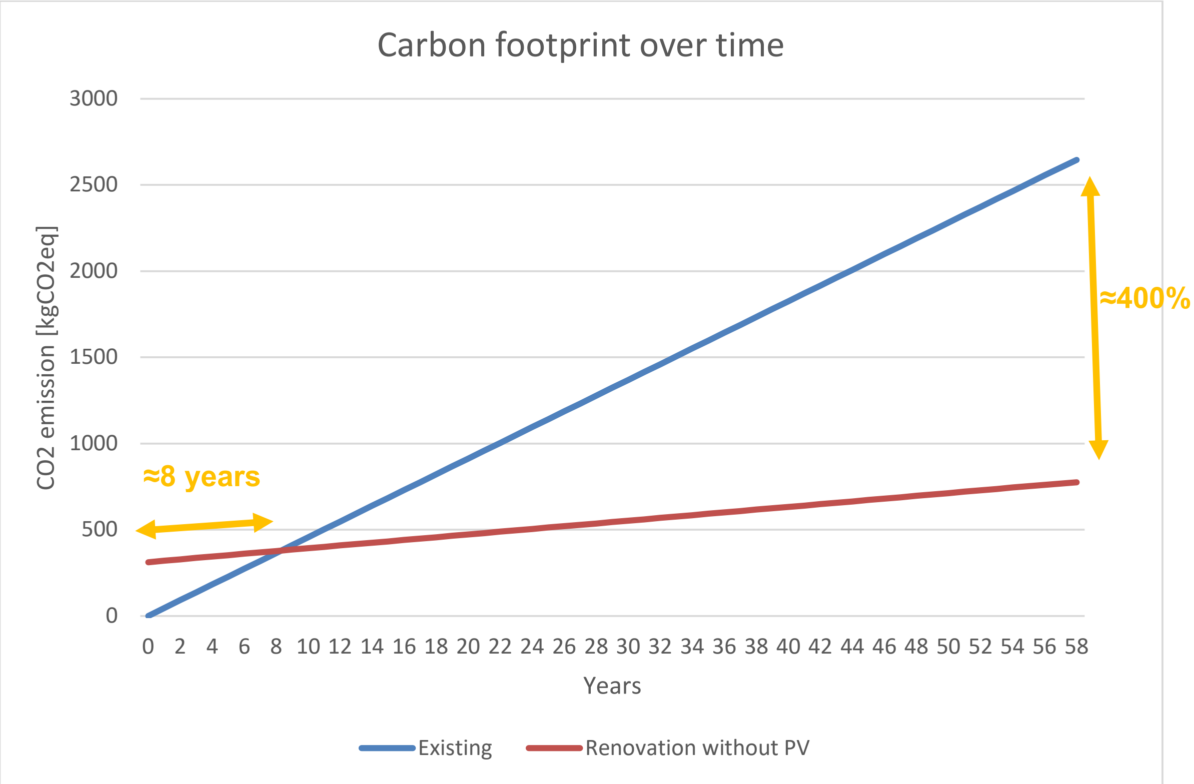
3 - CARBON FOOTPRINT OVER TIME

The renovation work on the building has both a direct additional footprint (use of new materials) and a long-term reduction of its energy consumption (which implies a decrease of the carbon footprint in the building use).

The carbon footprint over time analysis seeks to establish the point at which the total carbon emissions of the retrofit / refurbishment (including the embodied carbon of the materials), is less than the operational carbon emissions of the existing building.

	Before renovation work	After renovation work	Units
Heating consumption	150	13.3	kWh/yr/m²
DWH	31.1	6	kWh/yr/m²
Aux. electricity	0	1	kWh/yr/m²
Other electrics needs	22	14	kWh/yr/m²
Impact CO2 / kWh	0.25 (gas)	0.233 (electricity)	$kg_{eq}CO_2/kWh$
Carbon footprint	53.5	8	$kg_{eq}CO_2/m^2/yr$

The graph shows that based on the hypotheses outlined in the table below, it would take 8 years to achieve a net energy saving resulting in a return on “carbon investments”.



With a carbon investment of 350 $kg_{eq}CO_2$, we get a 400% payback (2000$kg_{eq}CO_2$ saving over 60 years).

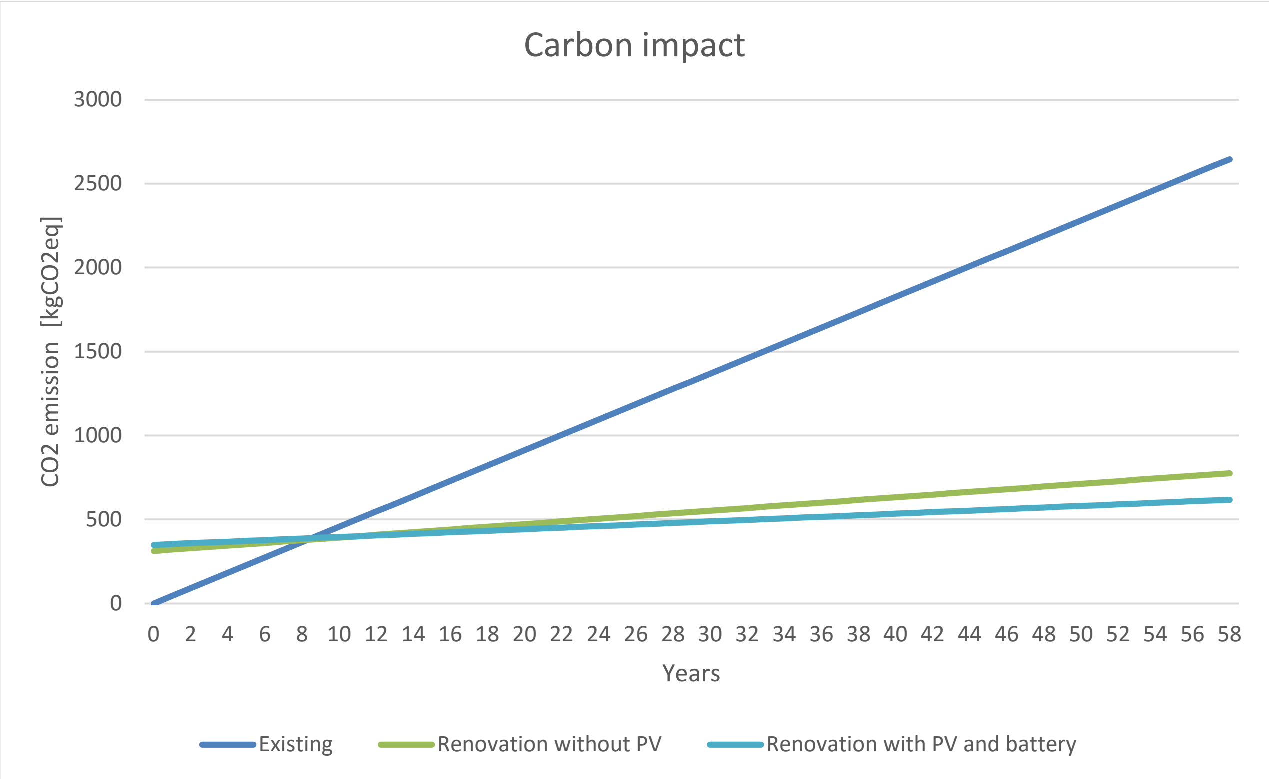
4 - PV CONSIDERATION

The following section also takes into account the PV and their associated impact. As part of this analysis an annual production of 4310 kWh and a Tesla battery lifespan of 25 years have also been considered.

The electricity carbon impact that we save when consuming our PV production is not the same when selling the electricity on the grid: **0.233 kg$_{eq}$CO2/kWh** with the self-consumption and **0.082** with the electricity sold to the grid.

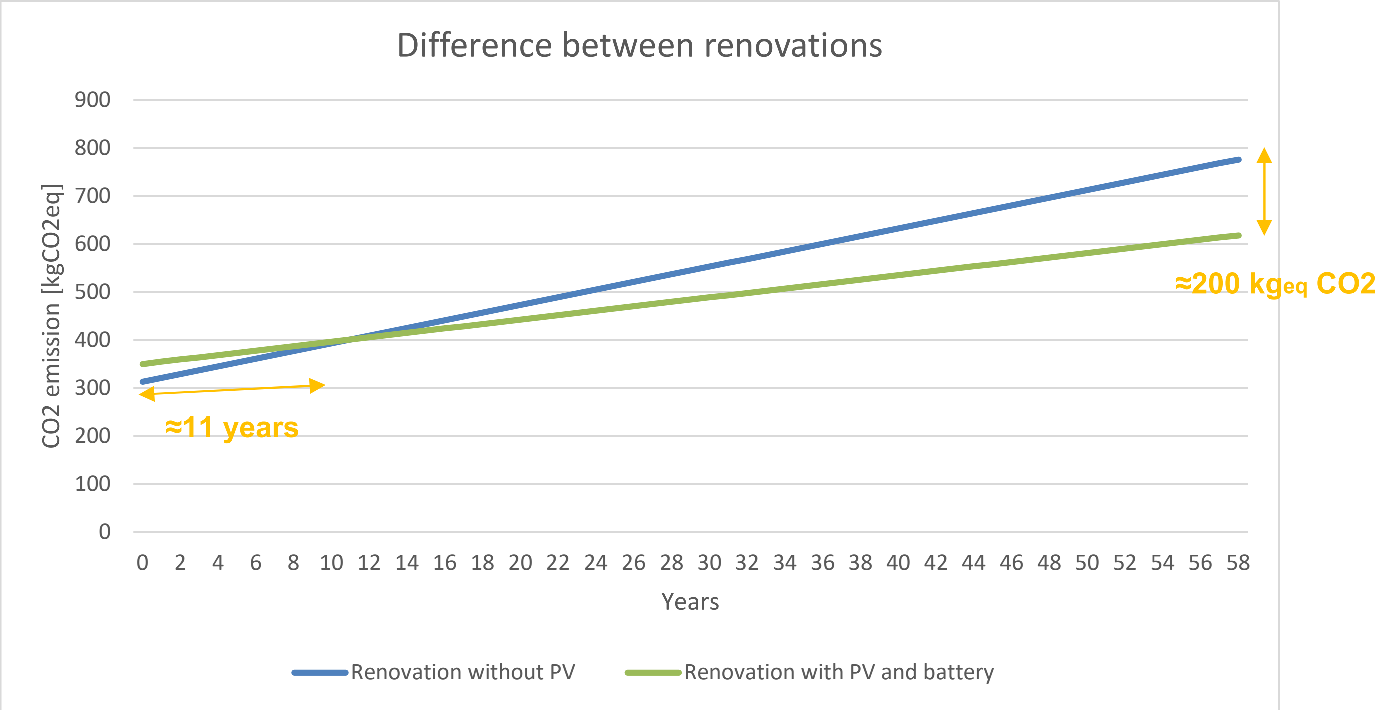
With battery			
Production		4310	kWh
Repartition	Self consumption	1810	kWh
	Grid sales	2500	kWh
	Self cons/m²	9,7	kWh/m²
	Grid sales/m²	13,4	kWh/m²
Grid sales impact	0,082	kgCO2/kWh	

Graph 1



Graph 1 shows the carbon impact of the existing building compared to two different options including renovation without PVs and renovation with PVs and battery. The graph clearly shows that the difference between the renovation options is small compared to that of the existing carbon impact.

Graph 2



To have a better sight of the difference between the three scenarios of renovation, the existing scenario is removed from graph 2.

A PV+battery system addition weights around 40 kg $_{eq}$ CO2 per square meter to build and install. However, in the long term, it allows a reduction of grid power consumption. An overall saving would be achieved after 11 years and after 60 years an overall reduction of 200 kg eq CO2/m².

5 - CONCLUSION

The use of bio-sourced materials with a negative CO_2 emission and the conservation of pre-existing structural elements allow the project to keep its carbon impact low, at around 350 kgC02eq/m².
Thanks to the massive energy savings induced by the EnerPHit retrofit, the project will have a 400% carbon return on investment. This value increases even more with PV installed, which saves energy consumption from the grid.
Therefore, the benefit of an EnerPHit retrofit is twofold: the impact of a retrofit is much lower than of a new construction, and the energy savings are a way to avoid large emissions of greenhouse gases.

It is important to note that the quantitative values presented here have a large incertitude and must be taken as an order of magnitude. As discussed in the Hypothesis part of the report, some of the carbon information is missing or difficult to estimate. However, the qualitative conclusions remain the same.